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USAFSAM-TP-89-7

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EVALUATION OF THE LOW-PROFILE RIGID-MOUNTED CABLE ADAPTER FOR THE MRL 450 SL-AF CARDIAC MONITOR

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August 1989

Interim Report for Period June 1987 - September 1987

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USAF SCHOOL OF AEROSPACE MEDICINE
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NOTICES

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a REPORT SECURITY CLASSIFICATION: Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S): USAFSAM-TP-89-7	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION: USAF School of Aerospace Medicine; 6b OFFICE SYMBOL (If applicable): USAFSAM/VNC	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code): Human Systems Division (AFSC) Brooks AFB TX 78235-5301	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION: Headquarters, Military Airlift Command; 8b OFFICE SYMBOL (If applicable): MAC/SGNL	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code): Scott AFB IL 62225	10 SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO 62202F; PROJECT NO 7930; TASK NO 16; WORK UNIT ACCESSION NO 02

11 TITLE (Include Security Classification)
Evaluation of the Low-Profile Rigid-Mounted Cable Adapter for the MRL 450 SL-AF Cardiac Monitor

12 PERSONAL AUTHOR(S)
Randolph, William R.; Roy, Ernest G.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year Month Day)	15 PAGE COUNT
Interim	FROM 87/06 TO 87/09	1989, August	14

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	
23	01		Test and Evaluation; Cardiac Monitor; MRL; Aeromedical Evacuation; Electromagnetic Interference
09	07		

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The Aeromedical Equipment Evaluation Laboratory tested the Low-Profile Rigid-Mounted Cable Adapter for the MRL 450-SL AF cardiac monitor. The laboratory found the LPRMC unacceptable for use in airevac, because the adapter is too easily damaged. Additionally, some Electromagnetic interference problems were identified with the MRL unit itself; suggestions for prevention and correction of those problems are described.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL: Rebecca B. Schultz, 2d Lt, USAF, BSC	22b TELEPHONE (Include Area Code): (512) 536-2937 / 22c OFFICE SYMBOL: USAFSAM/VNC

DD Form 1473, JUN 86 Previous editions are obsolete

EVALUATION OF THE LOW-PROFILE RIGID-MOUNTED CABLE ADAPTER FOR THE MRL 450 SL-AF CARDIAC MONITOR

BACKGROUND

The Medical Research Laboratories (MRL) 450 SL-AF is a cardiac monitor used by the U.S. Air Force in aeromedical evacuation. The Aeromedical Equipment Evaluation Laboratory (AEEL) at the U.S. Air Force School of Aerospace Medicine (USAFSAM/VNC), Brooks AFB, Texas, had initially evaluated the MRL in March 1985, and found it acceptable for use in flight. The 375th Aeromedical Airlift Wing (AAW), Scott AFB, IL, recently purchased twenty-three units. These units developed a problem with the preamplifier cable adapter, where the ECG cable connects to the unit. With use, the adapter would work loose from its mounting. The solution proposed by the manufacturer was a Low-Profile Rigid-Mounted Cable Adapter (LPRMCA), and in July 1987, the 375th AAW requested an evaluation of this device. The LPRMCA (Fig. 1) is 17.5 cm (7 in.) long, and can be installed on the MRL by removing a panel screw, inserting the LPRMCA into the ECG cable connector receptacle, and reinserting the panel screw through a recessed opening in the adapter mount (Fig. 2).

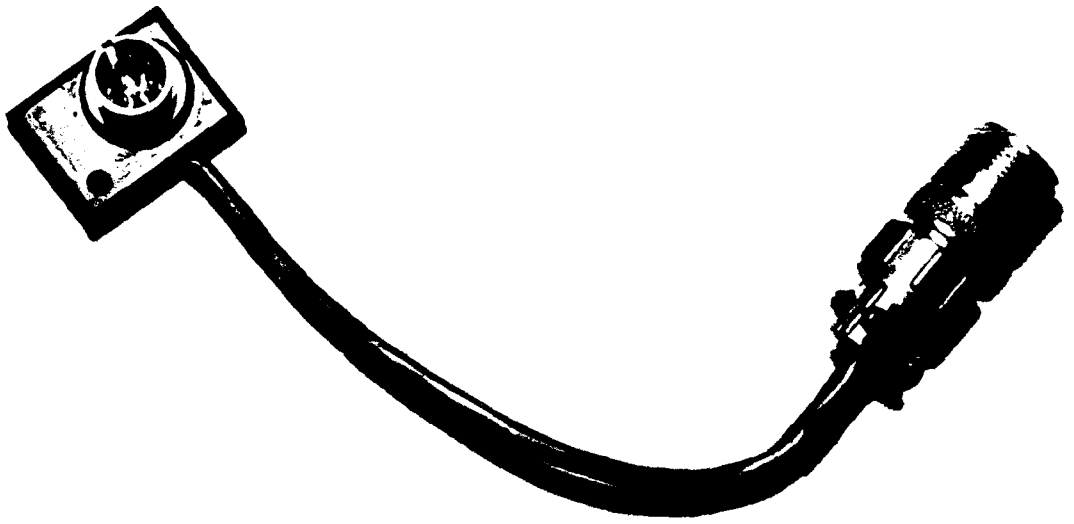

Figure 1. The LPRMCA.

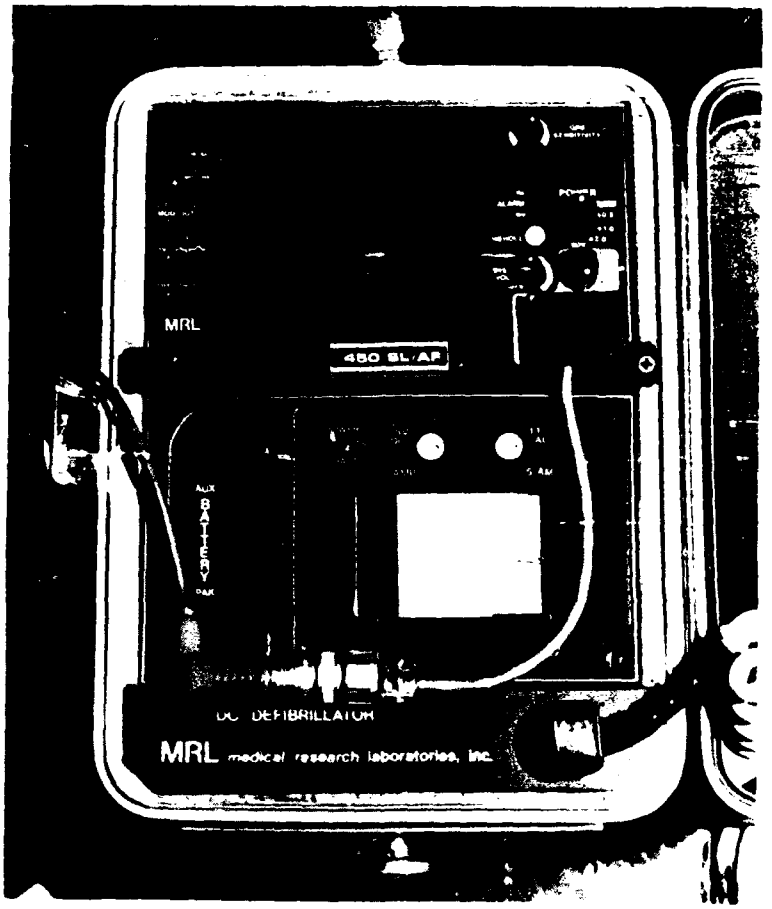

Figure 2. The MRL 450 SL-AF with LPRMCA.

METHODS

The AEEL develops test procedures that cover safety and human factors issues which apply to the equipment to be tested. Specifically, a "performance check" is developed which is a procedure that verifies proper functioning of the equipment under various conditions. An initial inspection is performed by the Lab's BEMT (Biomedical Equipment Maintenance Technician). The BEMT checks battery charging characteristics, leakage current measurements, ground resistance, and any other

measurements (i.e., temperature or pressure) necessary to verify that the device conforms to its specifications.

When the device has passed the initial inspection, it is subjected to various "referee tests" that check its performance under various anticipated operational conditions. The referee tests generally involve a repetition of the performance check under the specified conditions. Each referee test also includes any special measurements or procedures necessary due to the peculiarities of the testing conditions.

For this test, the LPRMCA was installed on an MRL 450 SL-AF, serial number 2109. The following is a description of each testing phase.

Performance Check. The performance check simply involved operating the MRL. A Medi Cal Instruments ECG simulator, Model 410, was connected to the MRL using the standard patient ECG cable. A 240 bpm (beats per minute), 2 mV signal was applied to the MRL. All controls on the MRL were set to maximum, except for the defibrillator and synchronizer which remained off. The unit was tested on each power supply: 115 VAC/60 Hz, 115 VAC/400 Hz, 28 VDC, and battery.

Initial Inspection. Only leakage current and ground resistance were measured. A battery performance check was unnecessary. Heart rate accuracy, defibrillator energy output and synchronization, and overall condition of the equipment were also checked.

EMI (Electromagnetic Interference). A performance check was performed during all phases of the Radiated Emissions and Conducted Susceptibility tests.

Vibration. Vibration tests were unnecessary.

Environmental. Temperature and humidity tests were unnecessary.

Altitude. Altitude testing was unnecessary.

Clinical Testing. Clinical testing was not necessary.

In-Flight Feasibility. In-flight feasibility studies were not necessary.

RESULTS

The initial inspection revealed that the LPRMCA extends out from the monitor in such a way that both the LPRMCA and monitor can be damaged when closing the lid. The AEEL therefore did not approve its use. However, the manufacturer has designed a new and much improved preamplifier connector which eliminates the need for the LPRMCA; the new connector will be incorporated into future devices.

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The Appendix contains copies of the original EMI charts for the tests run on the three MRL units. Each chart shows the spectral frequency range tested for that unit. The dashed lines on the charts indicate the acceptable limit for that frequency.

No performance degradation was noted during the EMI radiated susceptibility test. However, radiated EMI exceeded acceptable limits (1). The emissions were not from the LPRMCA, but were traced to the MRL 450 SL-AF itself. Two additional 450 SL-AF units, serial numbers 2130 and 2133, were tested. These units also had excessive radiated emission levels (Fig. 3). The emissions were traced to two sources.

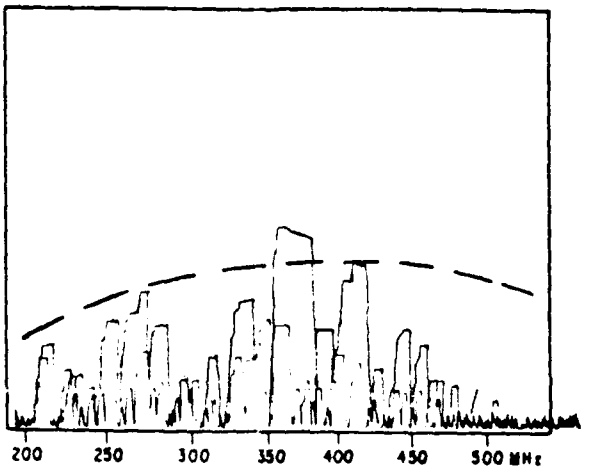

Figure 3. EMI test results.

The first source of excessive emissions was a switching transistor 2N4403, located on the Random Access Memory (RAM) Deflection Board. A check with MRL revealed that all units with serial numbers 2230 and below are affected. The 2N4403 transistor in these units must be replaced with a Ferranti 751 transistor to reduce the EMI to acceptable limits.

The second source of excessive emissions was caused by an unshielded AC power supply cord. The manufacturer states that all units were originally provided with a shielded power supply cord. However, the three field units tested did not have shielded cords. It should be noted that each of the three monitors had cords of different lengths, indicating that they may have been shortened or replaced since purchase. (To verify whether an AC power supply cord is shielded, remove the hospital grade plug and examine the ground pin connection for two wires. One is the electrical safety ground wire and the other is the AC power cord shield connection to ground.)

With the recommended modifications incorporated, the MRL 450 SL-AF radiated electromagnetic interference levels were within acceptable limits. Measured leakage current remained within acceptable limits both before and after the above modifications.

Finally, it was found that the amount of time the units could operate on battery power was excessively short. It varied from 45 to 120 minutes, compared with the manufacturer's specified time of 180 minutes operation with both the recorder and monitor operating.

CONCLUSIONS

The manufacturer's replacement of the cable connector eliminates the need for the LPRMCA. However, the transistor and power cord must be modified before the device will be approved. Additionally, we recommend placing a warning notice on the power cord warning that a shielded cord must be used on the monitor in the interest of flight safety. The operation and service manuals should have similar warnings.

In this report, we have identified a problem that could potentially exist with all aeromedical equipment. Once an item is tested for aeromedical use, it must not be modified or altered in any way without prior approval from both the 375th AAW and USAFSAM/VNC. This problem has been identified to the 375th AAW, and they plan to include a statement to this effect in all future equipment procurement specification packages.

REFERENCES

1. MIL-STD-461C, Electromagnetic emission and susceptibility requirements for the control of electromagnetic interference, Category A1e, 4 August 1986.

APPENDIX

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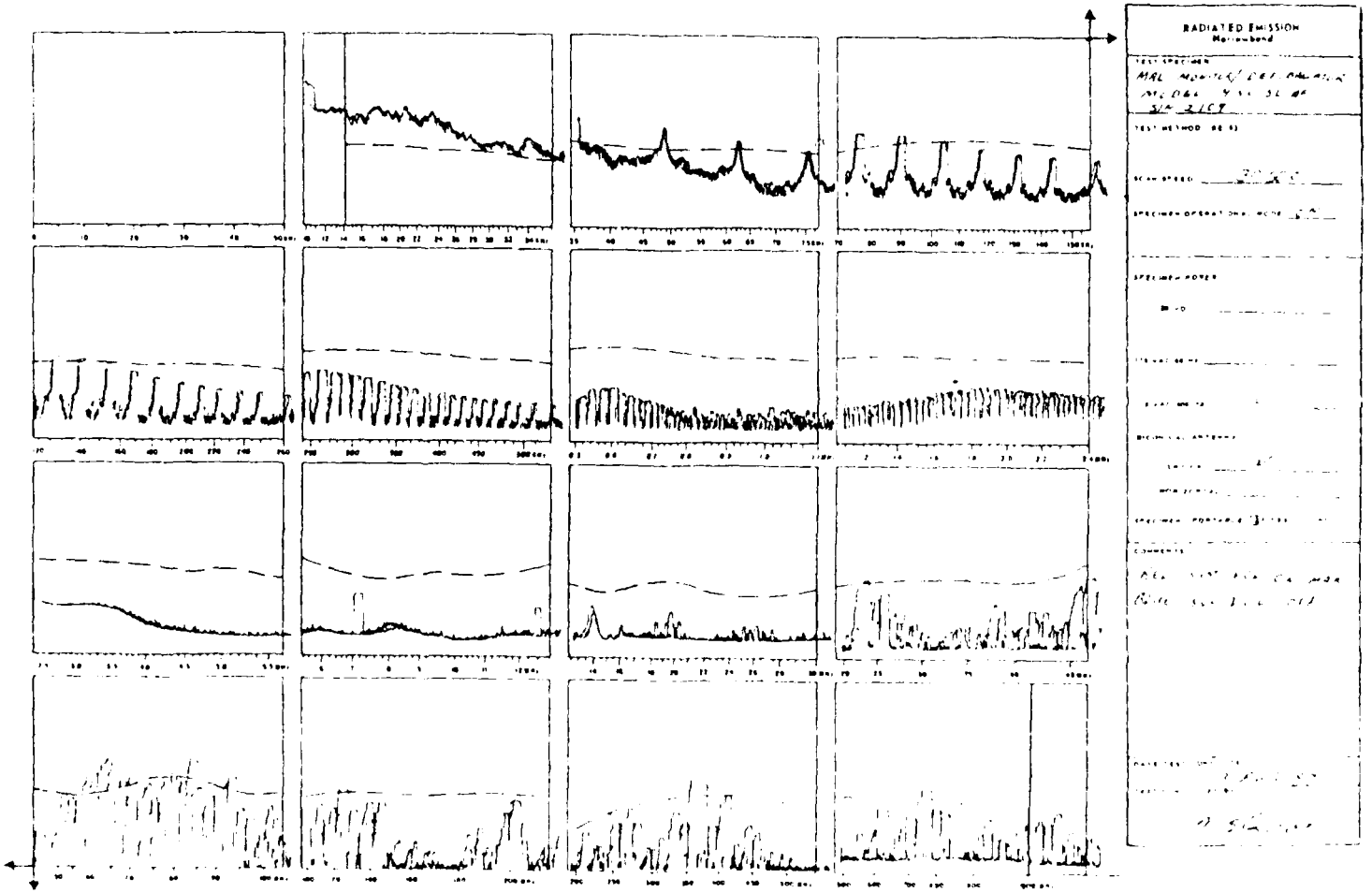
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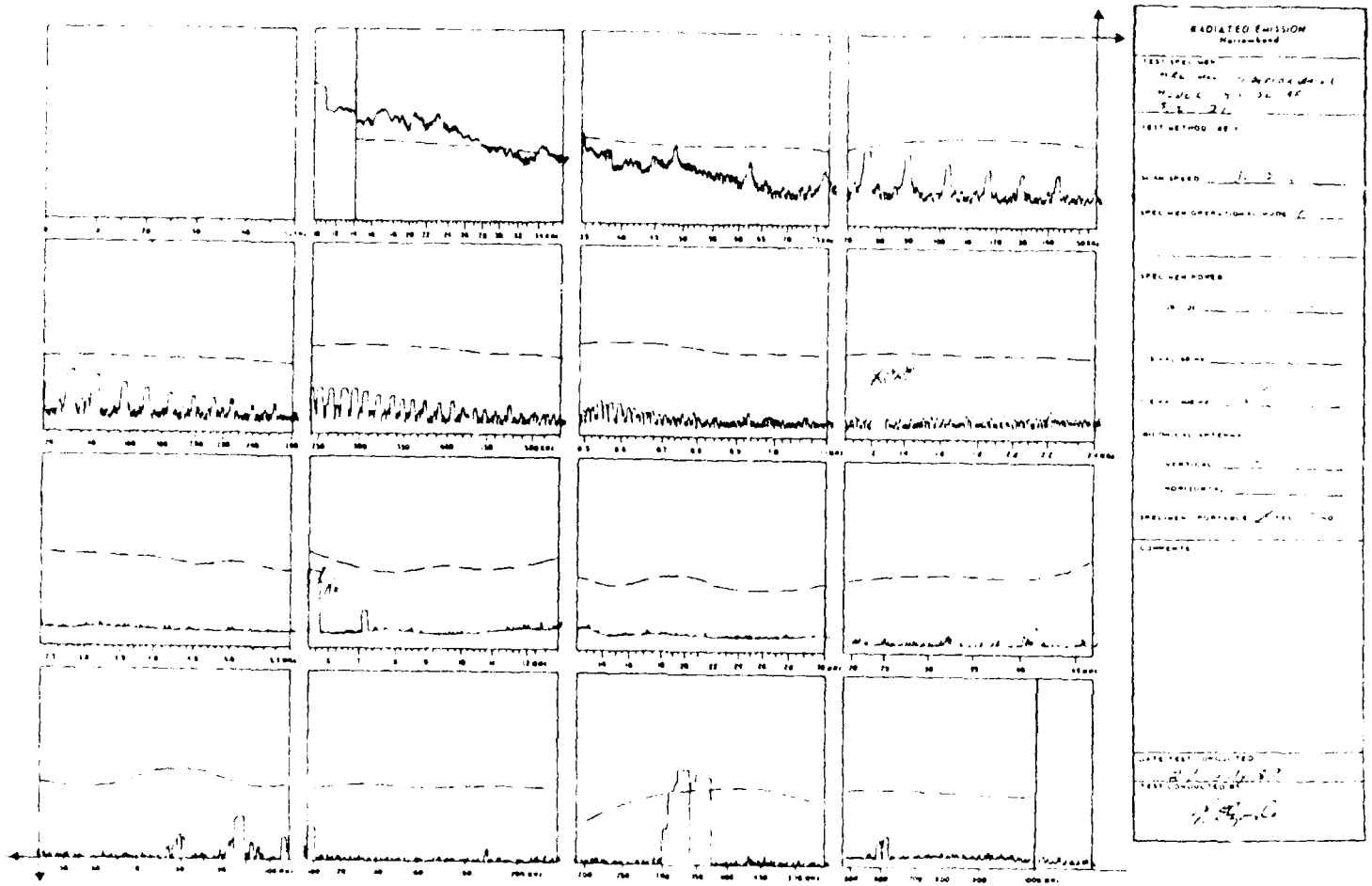
Narrowband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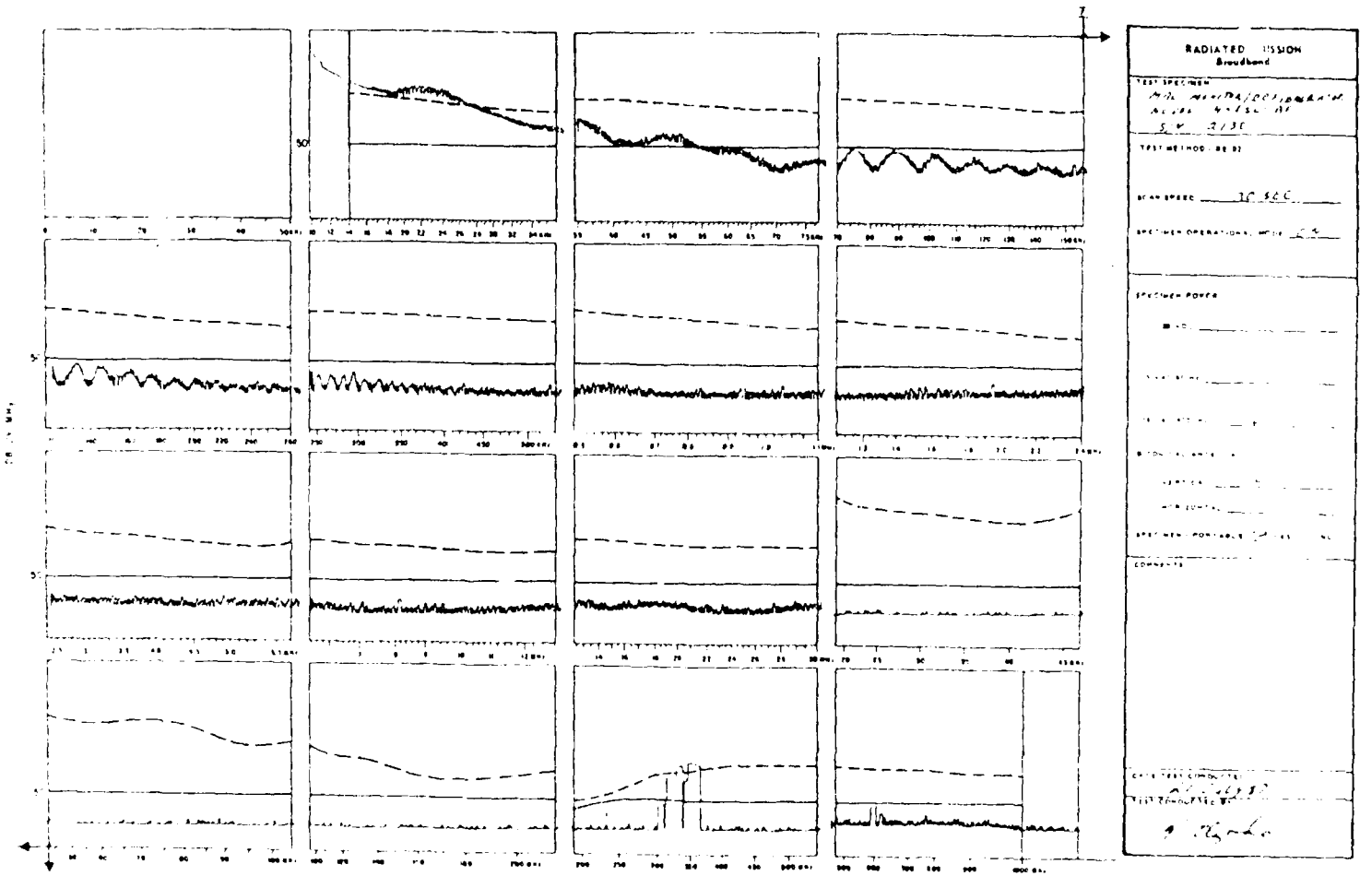
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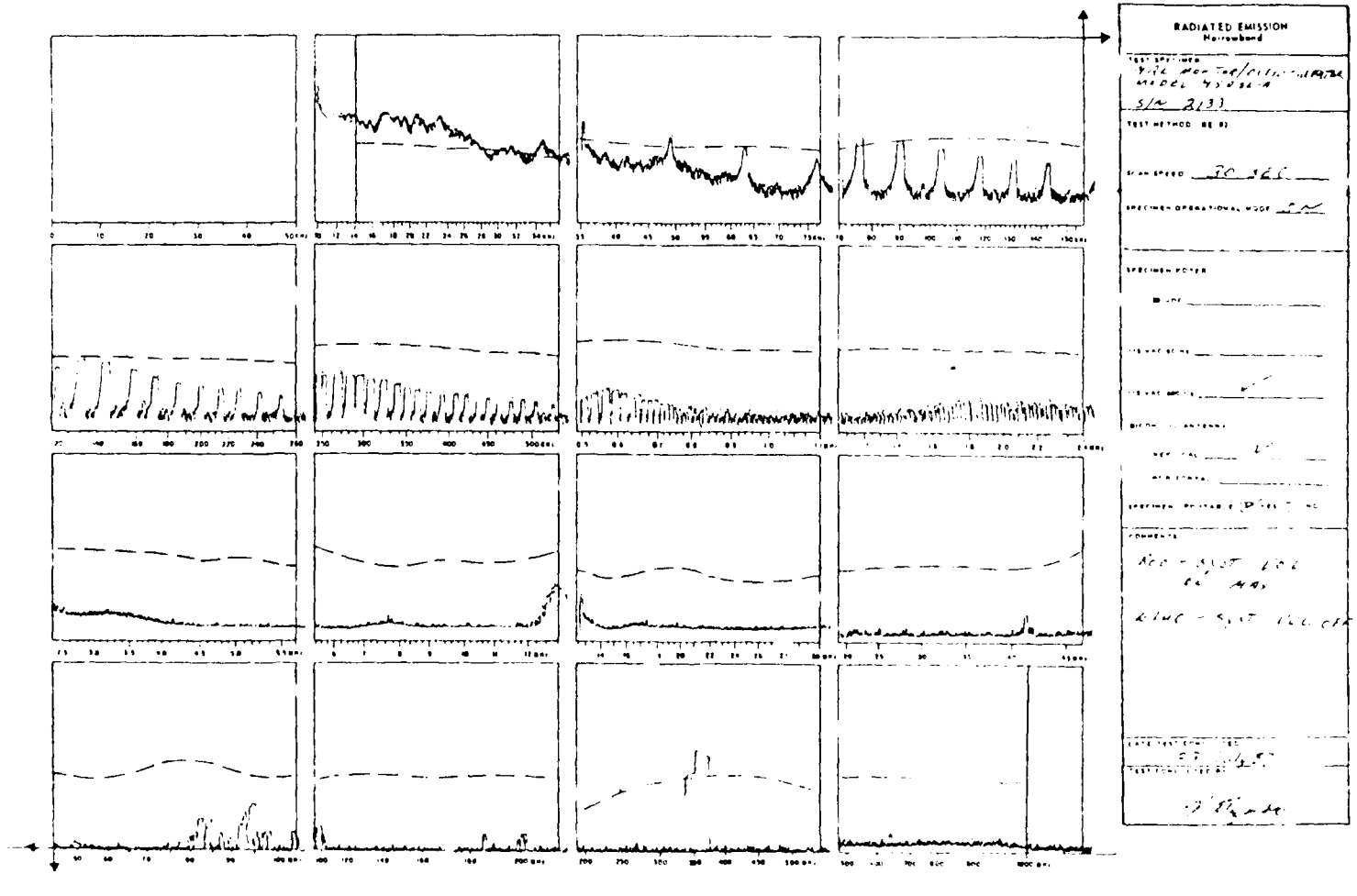
Broadband
TEST METHOD
SCAN SPEED
COMMENTS


RADIATED EMISSION
Narrowband